International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 12 **Issue:** VIII **Month of publication:** August 2024

DOI: https://doi.org/10.22214/ijraset.2024.64021

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Comparative Study of Analysis of Pre-Engineering and Conventional Steel Building using different Code

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Abstract: This project focuses on a comparative analysis and design of Pre-Engineered Buildings (PEB) using two different standards: IS 800:2007 (Indian Standard) and AISC (American Institute of Steel Construction), along with a comparison with Conventional Steel Buildings (CSB). Pre-Engineered Buildings have emerged as an efficient alternative to conventional construction due to their cost-effectiveness, faster completion time, and structural adaptability. The study evaluates the performance and design efficiency of PEB under both standards, highlighting the key differences and similarities in their structural design approaches. Through detailed analysis, the project aims to determine the most economical and structurally sound design method, providing insights that can guide future PEB projects in selecting appropriate design standards.
Keywords: Pre-Engineering Building, Staad Pro, IS 800:2007, AISC, Displacement, Bending Moment, Shear Force.

I. INTRODUCTION

A. General

The evolution of construction technology in India has been significantly influenced by the rise of Pre-Engineered Buildings (PEBs), which now account for 25% to 30% of the market share in the construction industry. PEBs offer numerous advantages, including environmental sustainability, economic viability, and reduced project costs due to minimal material wastage and lower labor costs. The shift from conventional construction methods to factory-built PEBs has been driven by the need for faster, high-quality construction, especially in the industrial and commercial sectors. This trend is now extending to residential construction as well, supported by global technological advancements and a growing emphasis on ecological building practices.\

B. Pre-Engineered Building

Pre-Engineered Buildings (PEB) are buildings which are Engineered and manufactured at factories and assembled at site. They mainly consist of Built-up sections, Cold-formed sections and Hot Rolled members. Built-up sections are fabricated at the factory to exact size, transported to site and assembled at site with bolted connections. Various components comprise the PEB like Main Frame, Gable end frame, Purlins, Girts, Columns, Rafters, Tie Beams and Bracings.

II. LITERATURE REVIEW

1) *Structural Efficiency and Design Optimization:* G. Ghanem et al. (2006) emphasized the structural efficiency of PEBs, particularly in the context of warehouses and industrial buildings. Their research pointed out that PEBs, consisting mainly of thin-walled steel profiles, are cost-effective and lightweight, offering a significant advantage in construction speed and material savings compared to CSB. Similarly, Peter Hradil et al. (2010) discussed the importance of minimizing the weight of structures in PEBs to reduce seismic and gravitational forces, thereby enhancing structural efficiency and reducing costs. Their study also highlighted the benefits of cold-formed profiles in PEBs, which are more economical than hot-rolled sections used in CSBs. Syed Firoz et al. (2012) further reinforced the efficiency of PEBs by comparing them to CSBs in warehouse construction. Their analysis using Staad Pro software and American codes demonstrated that PEBs could utilize thinner sections, thereby reducing the overall weight and cost of the structure. This reduction in weight not only lowers material costs but also decreases foundation requirements, making PEBs a more economical choice for high-rise warehouses.
2) *Economic Viability and Cost Efficiency*: Hisham Qureshi et al. (2013) explored the economic benefits of PEBs, noting that the reduction in base reactions and steel quantity in PEBs results in smaller footing sizes and overall cost savings.

Their study found that PEBs consume significantly less steel compared to CSBs, making them a more cost-effective option, particularly in large-span structures. The economic advantage of PEBs was also supported by C. M. Meera et al. (2013), who noted that the lightweight nature of PEBs reduces both construction time and costs, particularly in the erection process.

S.D. Charkha et al. (2014) highlighted the time efficiency of PEBs, noting that PEB structures can be completed in 6 to 8 weeks, compared to 20 to 26 weeks for CSBs. This reduction in construction time not only lowers labor costs but also allows for quicker occupancy and revenue generation. Their study concluded that PEBs offer a more sustainable and economical solution for industrial buildings, with a 30% reduction in construction costs compared to CSBs.

3) *Design Flexibility and Adaptability:* G. Sai Kiran et al. (2014) emphasized the design flexibility and adaptability of PEBs, particularly in resisting moisture, earthquakes, and adverse weather conditions. Their study pointed out that the latest design codes, such as IS 800:2007, have improved the structural performance of PEBs, making them a preferred choice for urban construction in India. Abhyuday Titiksh et al. (2015) also noted the rapid construction capabilities of PEBs, which are particularly beneficial in commercial and institutional projects where time is a critical factor.
4) *Comparative Studies and Practical Implications*: The comparative studies by L. Maria Subashini et al. (2015) and Vivek Thakre et al. (2016) further corroborated the advantages of PEBs over CSBs. Their research demonstrated that PEBs require less structural steel, reduce dead loads, and can be constructed in 30% to 35% less time than CSBs. These findings are consistent with the observations of Neha A. Daswat et al. (2016), who found that the prefabrication and controlled environment of PEBs lead to faster construction times and reduced costs, making them a more efficient alternative to CSBs.
5) *Sustainability and Environmental Impact:* Dharmalingam G et al. (2017) and Salim P.M. et al. (2017) discussed the sustainability of PEBs, highlighting their low maintenance costs, durability, and recyclability. Their research indicated that PEBs, with their efficient use of materials and energy, align with the principles of sustainable construction, making them a more environmentally friendly option compared to CSBs.

III. PROBLEM FORMULATION

A. General

This study aims to perform a comparative analysis and design of Pre-Engineered Buildings (PEBs) versus Conventional Steel Buildings (CSBs) using STAAD Pro software. The analysis focuses on evaluating the structural performance of both building types under Indian (IS) and American codes, considering factors such as bending moment, shear force, steel takeoff, displacement, and support reactions. The study models a single-story industrial warehouse structure located in Kurnool, with a span width of 24m, a length of 60m, and a bay spacing of 10m. The building is analyzed for wind conditions based on IS:875 (Part-3):2015. The research aims to determine the most economical and structurally efficient approach between PEBs and CSBs, considering varying design codes and environmental factors. The methodology involves detailed modeling, analysis, and comparison of results to draw conclusions on the suitability and cost-effectiveness of PEBs in the Indian context.

B. Combination of Models

For the comparative analysis, three different models are developed and analyzed using STAAD Pro:

1) Model-a: Conventional Steel Building (CSB) structure analyzed using the Indian IS code.
2) Model-b: Pre-Engineered Building (PEB) structure analyzed using the Indian IS code.
3) Model-c: Pre-Engineered Building (PEB) structure analyzed using the American code.

Each model represents a single-story industrial structure with identical dimensions, ensuring a fair comparison between PEBs and CSBs under different code provisions. The results from these models will be compared to assess structural efficiency, cost-effectiveness, and suitability for industrial applications in India.

IV. RESULTS

The following results are obtained

A. Maximum support reaction

The Graph 1 shows maximum support reaction is for CSB frame and minimum support reaction is for PEB frame design using AISC.

B. Maximum Shear Force

The below graph 2 shows maximum shear force is for CSB frame and minimum shear force is for PEB frame design using AISC.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 12 Issue VIII Aug 2024- Available at www.ijraset.com

C. Maximum Deflection

The below graph 3 shows maximum deflection is for CSB frame and minimum deflection is for PEB frame design using IS 800-2007.

D. Steel Quantity for Girt Members

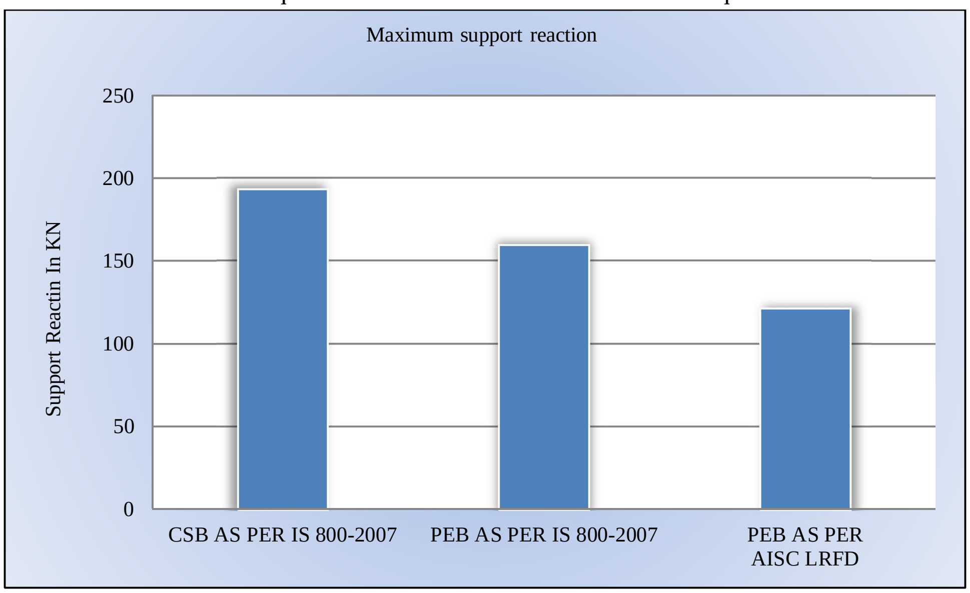
The above graph 4 shows maximum steel quantity for grit member is require for CSB frame and minimum steel quantity for grit member required for PEB frame design using AISC.

E. Steel Quantity for Purlin Members

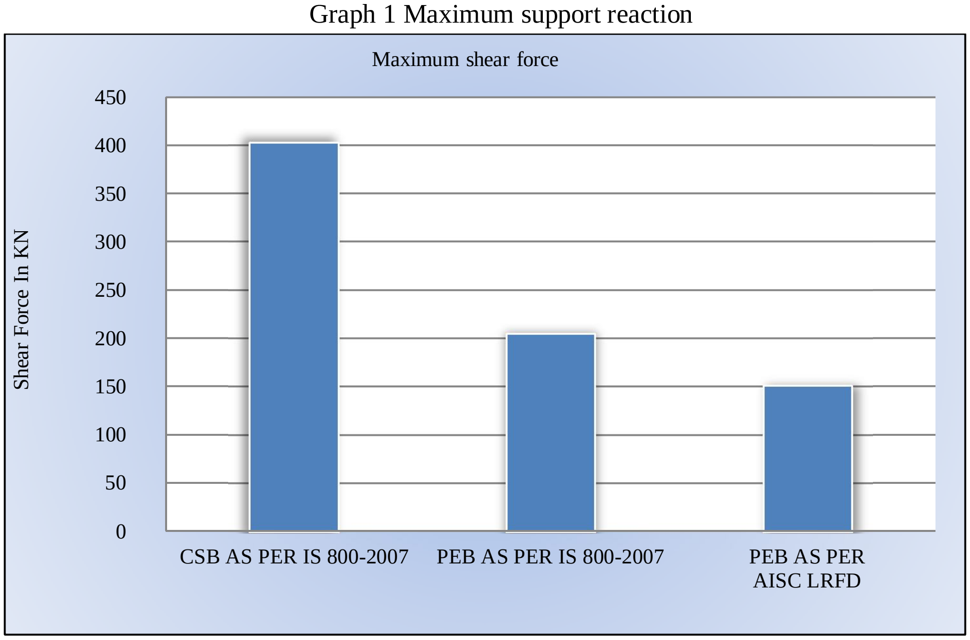
The above graph 5 shows maximum steel quantity for purlin member is require for csb frame and minimum steel quantity for purlin member required for PEB frame design using AISC.

F. Total Steel Quantity Comparison

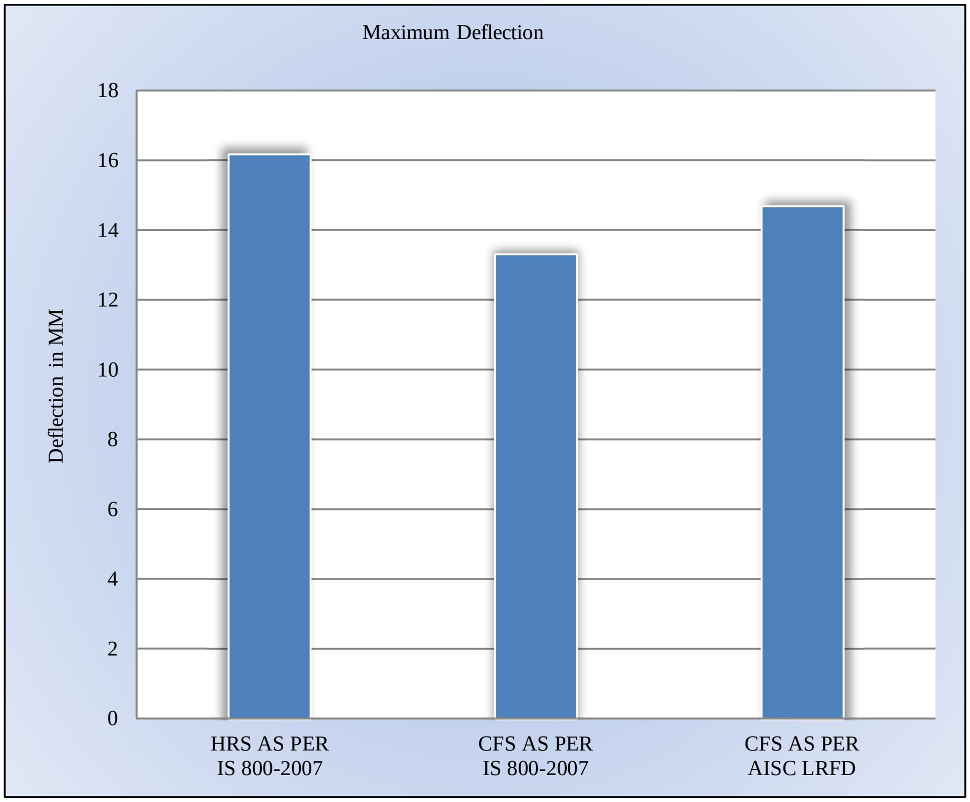
The above graph 6 shows maximum steel is require for csb frame and minimum steel required for PEB frame design using AISC.



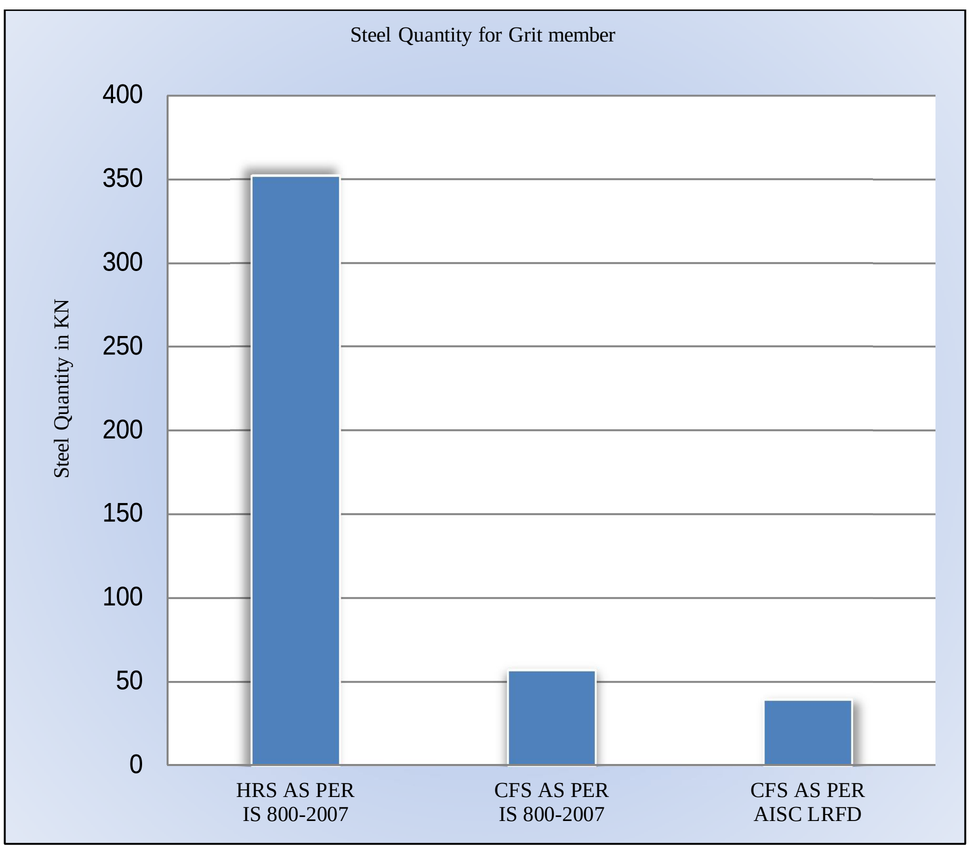
Graph 1 Maximum support reaction



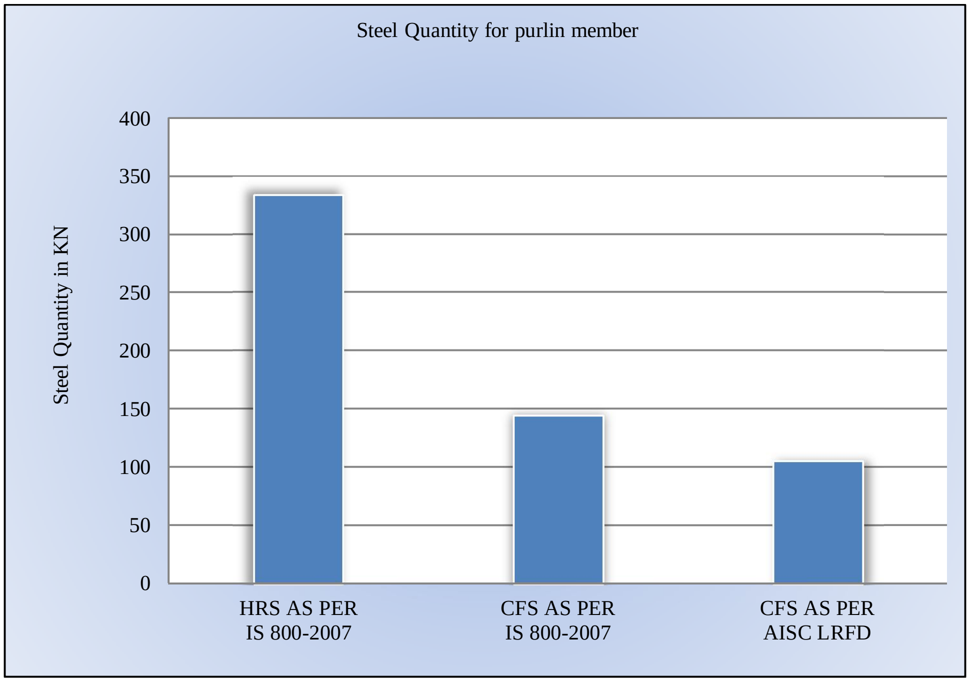
Graph 2 Maximum Shear Force



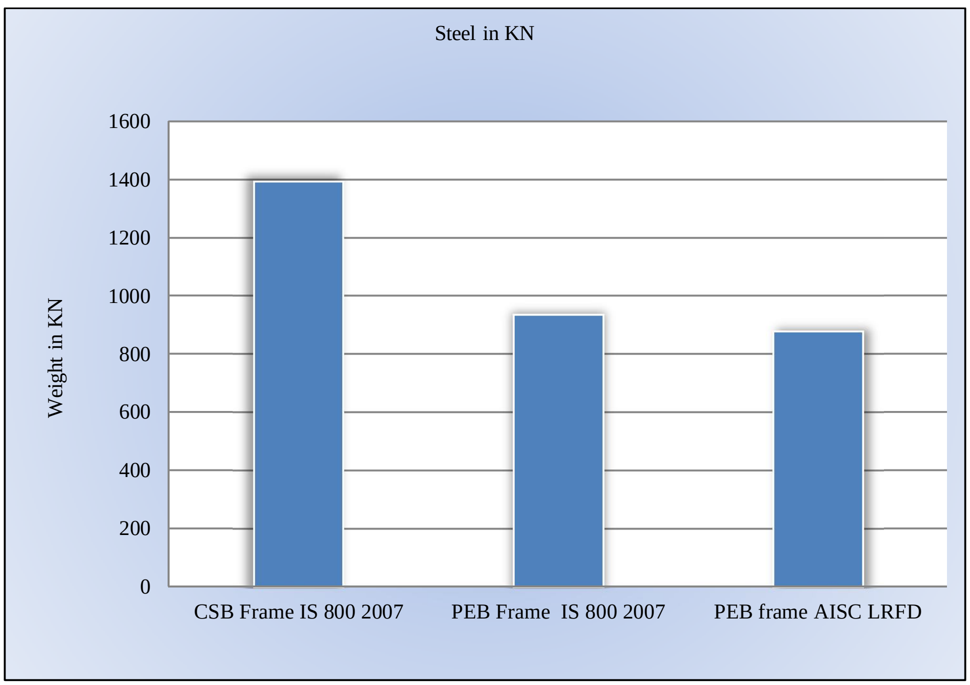
Graph 3 Maximum Deflection



Graph 4 Steel Quantity for girt member



Graph 5 Steel Quantity for purlin member



Graph 6 Steel Quantity

V. CONCLUSIONS

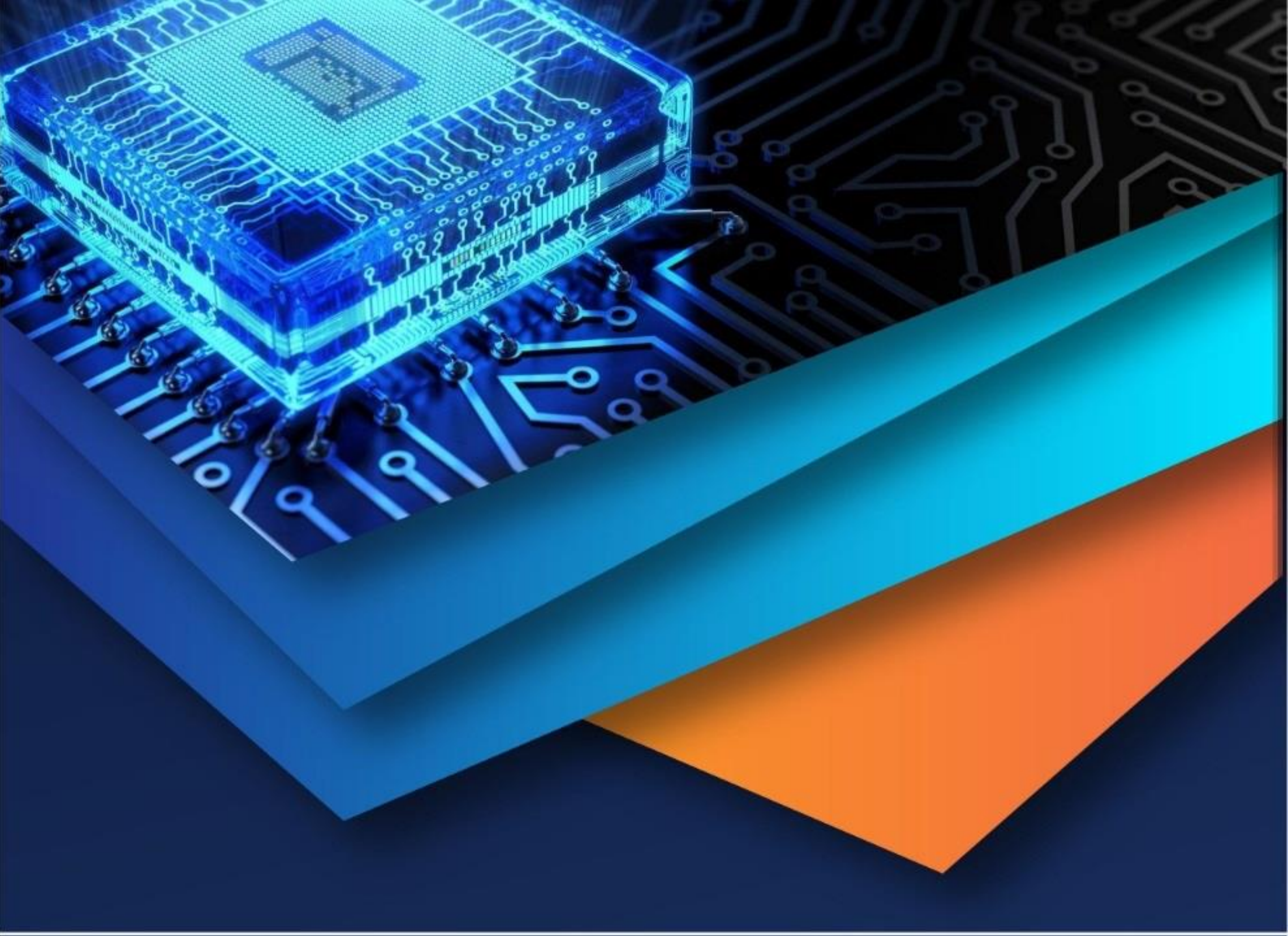
The study reveals that Pre-Engineered Buildings (PEBs) designed using both Indian and American codes are significantly lighter than Conventional Steel Buildings (CSBs), with weight reductions of 33% and 37% respectively. This weight efficiency is primarily due to the more stringent section limitations in the IS 800:2007 code. Additionally, PEBs demonstrate superior structural performance, exhibiting less displacement and lower shear forces compared to CSBs under identical loading conditions. This not only reduces material usage but also necessitates lighter foundations, leading to substantial cost savings.

In fact, the analysis shows that PEBs can achieve cost reductions of approximately 29% using the Indian code and 33% using the American code when compared to CSBs. This is largely attributed to the efficient sizing of structural members and the use of lighter materials, making PEBs a more economical choice for modern construction projects.

In conclusion, PEBs present a highly efficient, economical, and sustainable alternative to conventional steel structures, with significant potential for further adoption in the construction industry. The findings of this study underscore the importance of selecting appropriate design codes and methodologies to optimize structural performance and cost.

REFERENCES

[1] Abhyuday Titiksh, Abhinav Dewangan, Ankur Khandelwal, Akshay Sharma, “Comparative Study of Conventional Steel Building and PreEngineered Building to be used as an Industrial Shed”, International Journal of Engineering and Research and Application, Volume 5 , Issue 11, November 2015.
[2] Dharmalingam G Silambarasan G , “Design and Analysis of Pre-Engineered Building with Subjected to Seismic Loads using E-Tabs”, International Journal for Scientific Research & Development, Volume 5, Issue 04, 2017.
[3] G. Sai Kiran, A. Kailasa Rao, R. Pradeep Kumar, “Comparison of Design Procedures for PreEngineering Buildings (PEB): A Case Study”, International Journal of Civil, Architectural, Structural and Construction Engineering Volume 8 Issue No 4, 2014.
[4] Vivek Thakre, Laxmikant Vairagade. “Analysis and Cost Comparative study of Conventional Industrial building with PEB structure”, Journal of Information, Knowledge and Research in Civil Engineering. January 2016.
[5] L. Maria Subashiniand, Shamini Valentina, “Comparative Study of Pre Engineered and Conventional Industrial Building”, Indian Journal of Science and Technology, Volume 8, November 2015.
[6] Shrunkhal Bhagatkar, Farman Shaikh, Bhanu Gupta, Deepak Kharta, “A Study On Pre Engineered Building – A Construction Technique”, International Journal of Engineering and Research and Application, Volume 5, Issue 3, March 2015.
[7] Muhammad Saleem, Hisham Qureshi, “Design Solutions for Sustainable Construction of Pre Engineered Steel Buildings”, May 2018.
[8] Syed Firoz, Sarath Kumar, S.Kanakambara Rao, “Design Concept of Pre Engineered Building”, International Journal of Engineering and Research and Application, Volume 2, Issue 2, April 2012.
[9] Md. Sumon Reza, Shammya Afroze, Abul K. Azad. “International Journal of Innovations in Engineering Research And Technology”, Volume 5, Issue 1, January 2018.
[10] Petr Hradil, Matti Mielonen, Ludovic Fülöp, “Advanced design and optimization of steel portal Frames”, Rakenteiden Mekaniikka (Journal of Structural Mechanics) Volume 43, Issue 1, 2010.



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